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ENERGY PROCESSES IN A SIMPLE VORTEX OF ACOUSTIC INTENSITY

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Based on an analysis of experimental data, the acoustic field of a tonal signal with a frequency of 88±1 Hz is studied in shallow water conditions in the far field of a moving source. In a coherent acoustic field, a sixteen-channel system consisting of four combined receivers is used to observe the dynamics of acoustic energy movement in the region of an intensity vector vortex caused by a phase front dislocation. A vortex arising from a phase jump of $\pm 2\pi$ is called a simple vortex. Interference processes in the vortex generate direct flows passing through the vortex and reverse vortex energy flows that interfere with the direct flows and leave the vortex. There are no closed energy flows in the vortex.

Keywords: active and reactive intensity, intensity vector vortex, phase front dislocation, wave front reversal.

Reference

1. Nye J.F., Berry V.V. Dislocation in wave train // Proceedings of the Royal Society of London. 1974. Ser. A. Vol. 336, No. 1605. P. 165–190.

2. Baranova N.B., Zeldovich B.Ya. Dislocations of wave front surfaces and amplitude zeros. JETP. 1981. V. 80. No. 5. P. 1789-1797

3. Mann J., Tichy T., Romano A.J. Instantaneous and time-averaged energy transfer in acoustics fields // J. Acoust. Soc. Am. 1987. Vol. 82, No. 4. P. 17–30.

4. Waterouse R.V., Yates T.W., Feit D., Liu Y.N. Energy streamlines of a sound source // J. Acoust. Soc. Am. 1985. Vol. 78, No. 2. P. 758–762.

5. Zhuravlev V.A. Kobozev N.K., Kravtsov Yu.A. Phase front dislocations in an oceanic waveguide and their manifestation in acoustic measurements . Acoust Journal. 1989. Vol. 36, No. 2. P. 260–265.

6. Zhukov A.N., Ivannikov A.N., Kravchenko D.I., Pavlov V.I. Features of the fine energy structure of the sound field. Acoust Journal. 1989. Vol. 35, No. 4. P. 634–638.

7. Zhuravlev V.A. Kobozev N.K., Kravtsov Yu.A. Statistical characteristics of dislocations of the phase front of the wave field // JETP. 1992. Vol. 120, No. 2(8). P. 483–494.

8. Shchurov V.A. Vector acoustics of the ocean. Vladivostok: Dalnauka, 2003. 307 p. ISBN 5-8044-0301-X

9. Shchurov V.A., Kuleshov V.P., Tkachenko E.S. Phase spectra of interference of a broadband surface source in a shallow sea // Collection of proceedings of the XXII session of the Russian Acoustical Society and the Session of the Scientific Council of the Russian Academy of Sciences on Acoustics. M.: GEOS, 2010. Vol. 2. P. 248–251.

10. Shchurov V.A., Kuleshov V.P., Cherkasov A.V. Eddy properties of the acoustic intensity vector in a shallow sea // Acoust Journal. 2011. Vol. 57, No. 6. P. 837–843.

11. Shchurov V.A. Movement of acoustic energy in the ocean. Vladivostok. Information-polygraph. self-financing. center TIG FEB RAS. 2019. 204 p. ISBN 978-6043211-5-7 (Shchurov V.A., Movement of Acoustic Energy in the Ocean. Springer 2022. 204 p.)

12. ShchuroV.A., Tkachenko E.S., Lyashkov A.S., Shcheglov S.G. Description of the physical effects of acoustic field in a shallow sea waveguide // Underwater Investigations and Robotics. 2024. No. 3 (49) P. 4–12. (DOI: 10.37102/1992-4429_2024_49_03_01)

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